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MULTIDISCIPLINARY BENEFITS FROM BIOMONITORING STUDIES OF COOLING RESERVOIRS (U)

by

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A paper proposed for presentation at the
American Nuclear Society Winter Meeting
Washington, DC
November 11-15, 1990

and for publication in the proceedings

The information contained in this article was developed during the course of work under Contract No. DE-AC09-89SR18035 with the U.S. Department of Energy.

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Introduction

One of the most successful approachs to ascertain the mechanisms governing structure and function in limnetic communities has been to perturb these communities through *in situ* manipulations on several size scales ranging from small enclosures for phytoplankton-zooplankton interactions to larger scale enclosures, and finally to whole-lake/ecosystem manipulations (Carpenter 1989). Most recently whole-lake manipulations have focused on the problem of accelerated eutrophication in shallow and productive basins in the form of "bottom up" control through the reduction of allochthonous nutrient loadings and "top down" control through selective fish stockings (Benndorf 1988). Cooling reservoirs for fossil-fueled power plants or nuclear

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reactors offer unique opportunities. Besides experiencing episodic thermal impacts, sometimes out of phase with ambient temperate cycles, cooling reservoirs have much more variable retention times that often determine phosphorus and nitrogen loading rates and thus basin productivity. When constructed, basin morphometry, littoral regions, and fish stockings are deliberately designed to conform to desired uses. Public access, especially commercial and sport fisheries, is sometimes restricted. For these reasons this specialized type of reservoir offers limnologists unique opportunities to observe and manipulate structural and functional features of the basin in much the same fashion as large scale limnocorrals or whole-basin experiments would accomplish in a natural lake. Therefore, biomonitoring studies of once-through cooling reservoirs for nuclear reactors not only provide field and laboratory information for environmental compliance, but also offer results which benefit lake and reservoir management constructs and limnetic community ecology.

Description of actual work

Biomonitoring programs have been performed at the Department of Energy's Savannah River Site to provide information for compliance with Section 316a of the Clean Water Act. On Par Pond and Pond B comprehensive field efforts monitored nutrient chemistry, plankton populations, fisheries, benthic assemblages, and littoral zone biota from 1983 through 1985 (Figure 1). A similar effort, begun in 1985 and continuing through 1992, is in progress on L Lake. Results have indicated that nonplanned whole-basin manipulations and the comprehensive intensity of monitoring studies offer new insights into how limnetic communities function.

Results

Field results from L-Lake's first three years existence indicated the impact of physical events on both sampling variations in the water column and on abiotic/biotic basin

dynamics. Variability of temperature, pH, DO, chlorophyll *a*, and several species of Cladocera was greatest at the basin's inlet and outfall dam indicating lengthwise unimodal seiching in the water column. Depth-integrated primary production was principally a function of the seasonal temperature regime with light-limited growth, and nitrogen and phosphorus loading from the Savannah River also influencing growth (Figure 2). These results followed the "bottom up" model which proposes that primary productivity, regulated by nutrient loading, sets boundary conditions on lake metabolism and ultimately piscivorous fish abundance.

The most striking feature of the lake's pelagic community was the dominant effect of size-selective predation by threadfin shad on the macrozooplankton species abundance (Figure 3). As threadfin abundance steadily increased, total zooplankton abundance, composed of all size classes of animals increased, Cladoceran densities of relatively large species, decreased to near extinction levels. This succession follows the classic "top down" model which states that size-selective fish predation controls the relative abundance and size distributions of their zooplankton prey assemblages.

References

Benndorf, J., 1988. Objectives and unsolved problems in ecotecnnology and biomanipulation: A preface. Limnologica. 19:5-8.

Carpenter, S. R. 1989. Replication and treatment strength in whole-lake experiments. Ecology. 70:453-463.

FIGURE 1.

316a studies nabs

SRS 316a Monitoring Studies

Program	1985- L Lake	1983-85 Par Pond	1983-85 Pond B
Water quality	X	X	X
Phytoplankton			
productivity	X	X	X
taxonomy	X	X	X
Periphyton			
productivity	x		
taxonomy	x		
Zooplankton	X	X	X
Macroinvertebrates	X	X	X
Fish			
ichthyoplankton	X	X	X
adult fish	X	X	X
Aquatic macrophytes	X		
Reptiles and amphibians	X		
Waterfowl	X		

FIGURE 2.

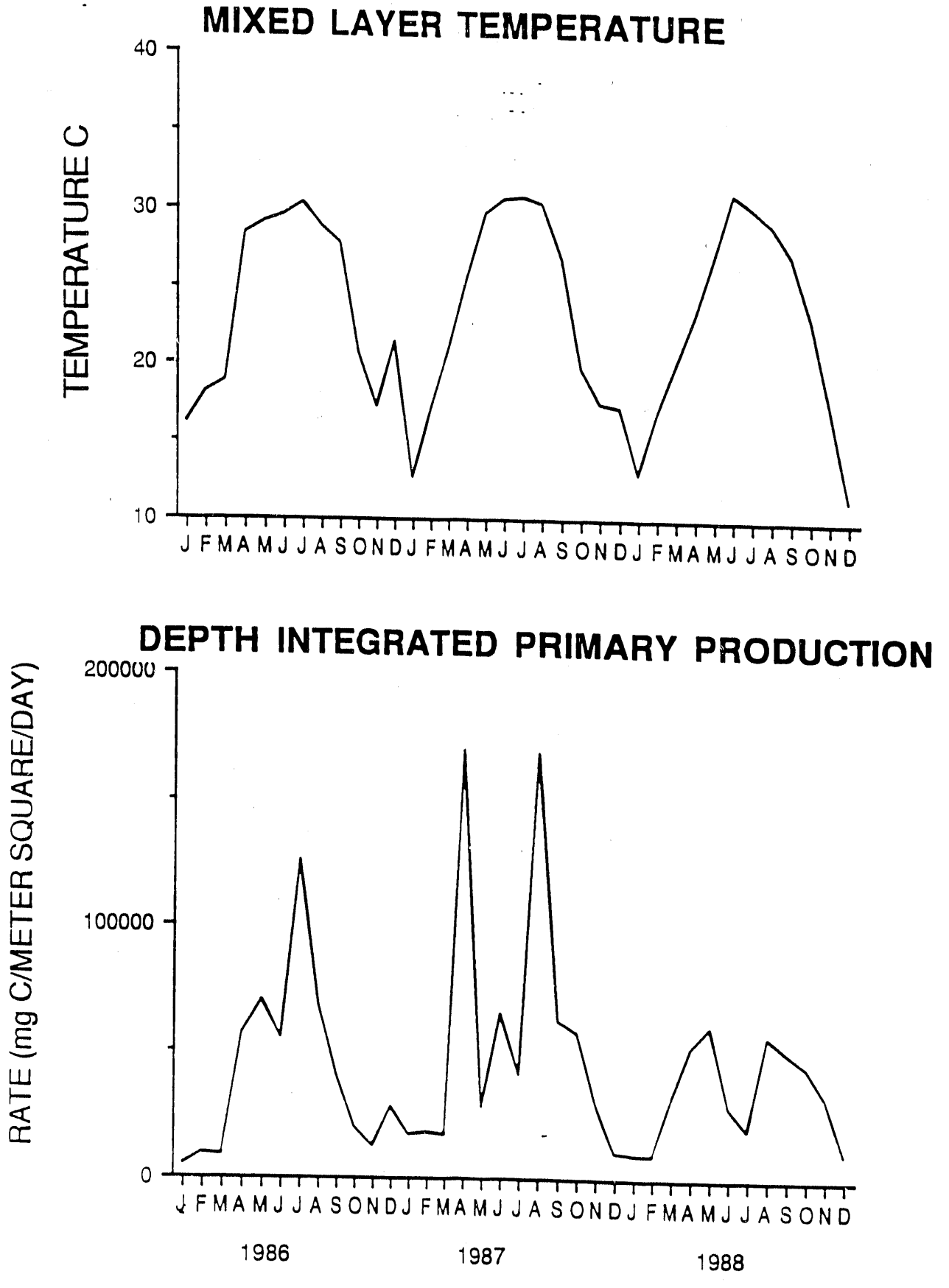
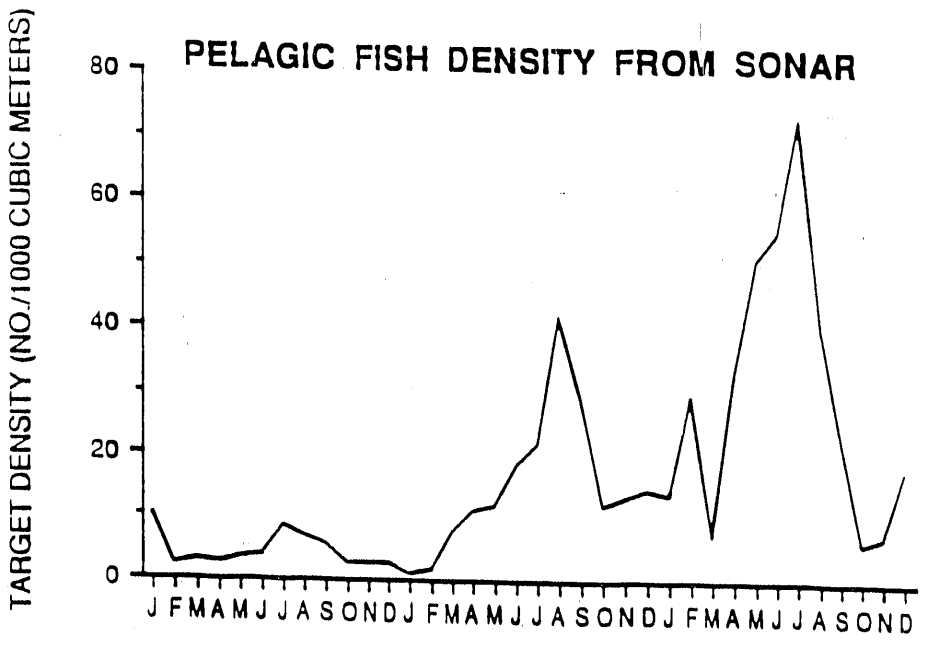
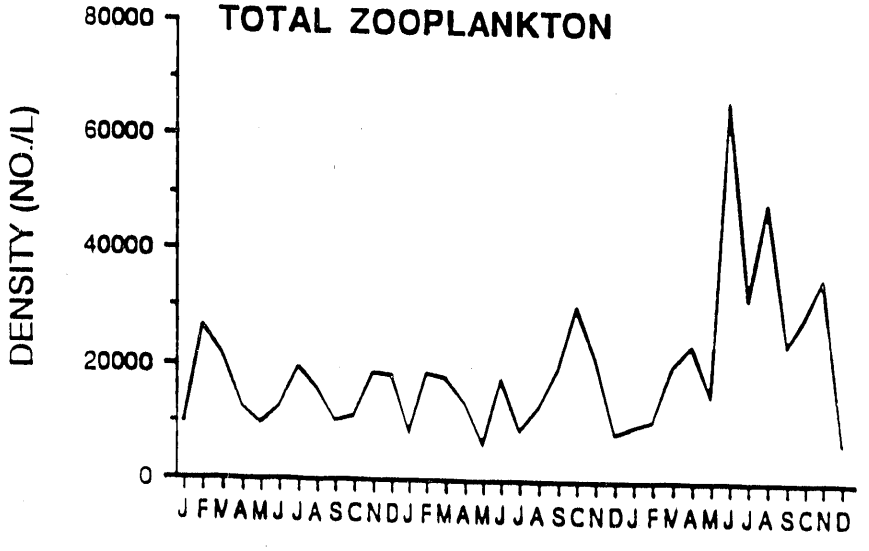
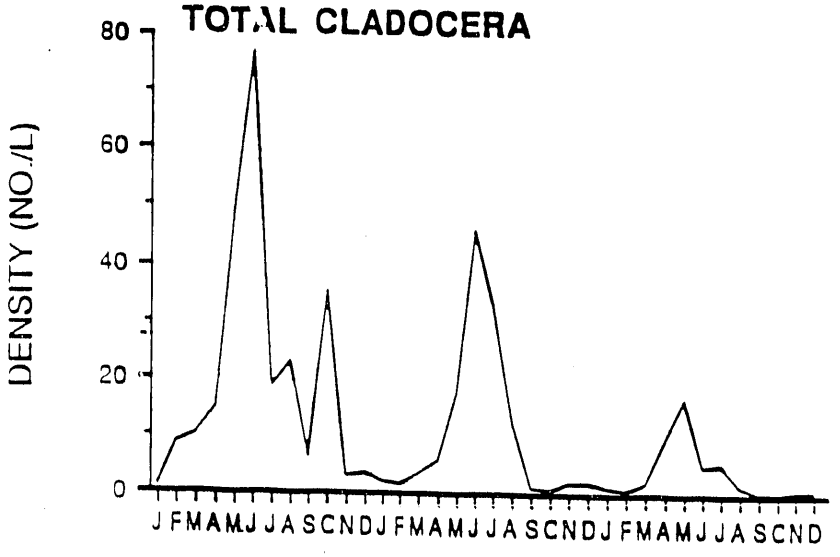

MIXED LAYER TEMPERATURE
TEMPERATURE C
40
30
20
10
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
DEPTH INTEGRATED PRIMARY PRODUCTION
RATE (mg C/METER SQUARE/DAY)
200000
100000
0
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1986
1987
1988

FIGURE 3.


PELAGIC FISH DENSITY FROM SONAR
TARGET DENSITY (NO./1000 CUBIC METERS)
80
60
40
20
0
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D


TOTAL ZOOPLANKTON
DENSITY (NO./L)
80000
60000
40000
20000
0
J F M A M J J A S C N D J F M A M J J A S C N D J F M A M J J A S C N D


TOTAL CLADOCERA
DENSITY (NO./L)
80
60
40
20
0
J F M A M J J A S C N D J F M A M J J A S C N D J F M A M J J A S C N D

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